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2. Patent application number *(The Patent Office will fill in this part)* — 0404655.3

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

THORSTONE BUSINESS MANAGEMENT LIMITED
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Patents ADP number *(if you know it)* — 7527336002

If the applicant is a corporate body, give the country/state of its incorporation — ISLE OF MAN

4. Title of the invention — GLASS PRODUCTS

5. Name of your agent *(if you have one)* — GRAHAM F COLES

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

GRAHAM COLES & CO
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Patents ADP number *(if you know it)* — 4361556001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Description 8

Claim(s)

Abstract

Drawing(s) 3 only

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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

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11. I/We request the grant of a patent on the basis of this application.

Signature Graham F Coles Date 2/03/04.

12. Name and daytime telephone number of person to contact in the United Kingdom

GRAHAM F COLES ☎ 01494 677181

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Glass Products

This invention relates to glass products, and is concerned especially with powder-coated glass products and methods of their manufacture.

According to one aspect of the present invention there is provided a method of coating a glass substrate wherein a thermosetting powder is deposited on the substrate and the powder is cured to form the coating by heat applied to the powder through the substrate.

The substrate may be heated prior to deposition of the powder so that the powder adheres to the glass surface as it is deposited. Adhesion may be enhanced by use of an adhesion promoter included within the powder; alternatively, the surface on which deposition is to take place may be pre-treated with the promoter.

In previous methods of powder-coating a glass substrate, heat to cure the deposited powder is applied from above the substrate, rather than as with the present invention, through the substrate. With heat for curing the powder applied through the substrate in accordance with the present invention, the powder cures progressively from the substrate upwardly through the thickness of the powder deposit so as to ensure that gasses are not trapped in the resultant coating and that the resultant coating is generally homogenous without hole or 'fisheye' defects.

It has been found advantageous to maintain the region above the powder at a substantially-constant temperature, preferably below that required to melt the powder.

According to another aspect of the present invention there is provided a glass product wherein a glass sheet is backed by a powder coating and metal foil is bonded to the back surface of the coating to extend inwardly from the edges of the product for thermal protection of the product.

The powder coating may be an epoxy coating.

A powder-coated glass panel and a method of manufacturing it, all according to the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a representative section of part of the powder-coated panel of the invention;

Figure 2 is a partial plan view from the rear of the panel of Figure 1;

Figure 3 is illustrative of an oven used in the manufacture of the panel of Figures 1 and 2; and

Figure 4 is a perspective illustration from the rear of part of a double-glazing unit incorporating a slightly-modified form of the panel of Figures 1 and 2.

Referring to Figure 1, the panel is faced by a rectangular sheet 1 of clear glass (having a thickness, for example, of 6 mm) which carries a transparent, polyester powder-coating 2 that is bonded to a back surface 3 of the sheet 1. The back surface 4 of the coating 2 is printed with one or more images in ink 5 and the whole of the printed surface 4 is covered by a further powder-coating 6 of white or other colour. The coating 6, which provides the background against which the one or more printed images on the surface 4 can be

viewed through the glass, is of an epoxy resin. Both coatings 2 and 6 have a thickness of 250 μm.

Referring now also to Figure 2, the four side-edges of the panel are covered respectively by four strips 7 of aluminium (or other metal) foil that are bonded to the panel and are mitred to one another (but may overlap) at the corners. Each strip 7 extends lengthwise along its respective side-edge of the panel and has longitudinal margins 8 and 9 that are bonded and wrapped round onto, respectively, the front surface 10 of the glass sheet 1 and the back surface 11 of the coating 6.

The panel of Figures 1 and 2, which may be used for example for architectural purposes, is manufactured using a method according to the present invention, in which the glass sheet 1 is first cleaned in a washing station. After drying, the sheet 1 is heated to 160 degrees Celsius and moved horizontally by conveyer with its surface 3 uppermost into a station where polyester thermosetting powder-coating material in finely-divided form is deposited on the surface 3 by electrostatic or tribostatic method. Because the sheet 1 is pre-heated, the powder tends to adhere to the surface 3 so that the deposit is not easily disturbed and good dispersion of the powder is achieved.

The sheet 1 carrying the deposited polyester powder is next moved into an oven where heat is applied to bring the powder through its melt phase into its gel state. The heat is applied through the sheet 1 from below to raise the temperature of the powder to some 180 degrees Celsius. The powder-coating material is brought to a substantially hard, but not to the fully cross-linked final form of the coating 2, leaving it about 70% cured.

One or more images in the ink 5 are now printed on the back surface 4 of the coating 2 in its partly-cured state, using a silk-screen, bubble-jet or laser printing technique. The printing may be half-tone or line print, and where colour is involved is applied as a colour-separated print image. The ink used is a hybrid to the extent that it has ultra-violet and thermo-curing properties. The ultra-violet curing property is used between successive steps in the colour-separation process to harden the ink after each ink application to the extent that the print is touchable without smudging and will not run, but is still soft; desirably the ink contains a reactive agent that gives it a high cure-rate to ultra-violet light. The print is applied in the reverse order from convention, since the image is to be viewed through the glass sheet 1 and clear coating 2.

Following application of the print image(s), epoxy thermosetting powder-coating material containing appropriate pigments to give the white or other colour for the background to the printed image(s), is deposited in finely-divided form on the printed surface 4 by electrostatic or tribostatic method. The sheet 1 with the deposited epoxy powder is now moved into a curing oven where the epoxy powder is melted and cured into the hardened coating 6 concurrently with completion of cure of the coating 2 and ink 5. The thermo-cure agent of the ink ensures that the print fuses into the coatings 2 and 6 as they harden fully into one, and the epoxy coating 6 fuses into the polyester coating 2 between the elements of ink 5.

Heat for bringing the coatings 2 and 6 and the ink 5 into the fully-cured state is applied through the sheet 1 from below to raise the temperature of the powders to some 200 degrees Celsius, in the curing oven. The general form of the curing oven is illustrated in Figure 3 where the

glass sheet 1 carrying the uncured coatings 2 and 6 is shown being moved in the direction of the arrow A from one to another of a pair of delivery rollers 20 (which are surfaced with glass fibre) of the conveyor system of the manufacturing plant.

Referring to Figure 3, the oven includes two elongate, tubular infra-red lamps 22 that are contained within a trough 23 that is set between the rollers 20. The trough 23 has a highly-reflective internal surface 24 and a lid 25 of a borosilicate glass, and the rollers 20 hold the sheet 1 at a spacing of 3 mm above the lid 25 and about 75 mm above the lamps 22. During operation, the air in the trough 23 becomes superheated so that owing to the proximity of the sheet 1 to the lid 25 heat is induced into the sheet 1 by conduction across the gap from the lid 25 as well as by radiation from the lamps 22. Conduction of the heat through the sheet 1 and upwardly through the coating 2 brings about, fusion and cure of the epoxy material progressively upwards through the coating 6, together with full cure of the coating 2 itself and the ink 5. This, as with the polyester coating 2, reduces the likelihood of defects in the resultant coating 6.

The environment within the oven above the sheet 1 is closely controlled, the temperature being kept as near ambient as possible without disturbing the epoxy powder; air circulation has less effect as the powder cures. Furthermore, the radiation from the lamps 22 is controlled in frequency to give high-frequency radiation initially, reducing in steps or otherwise to low-frequency radiation as the powder cures.

The same general construction as that of the curing oven illustrated in Figure 3, may be used for the station in which the glass sheet 1 is pre-heated prior to deposition

of the polyester powder for the coating 2, and also for the oven in which the polyester powder is heated to the gel state.

The polyester powder contains a silane-enriched extender for promoting adhesion of the coating 2 with the glass surface 3. However, as an alternative, a silane film may be sprayed onto the surface 3 prior to deposition of the powder; the silane spray may be applied after the sheet 1 has been heated to 50 degrees Celsius and before it is pre-heated to 160 degrees Celsius.

The epoxy coating 6 acts as a water and moisture barrier to the extent that it does not need to be protected from weathering. However, the strips 7 of metal foil are applied to the side-edges of the panel to afford protection to the polyester coating 2, and to its interface with the glass surface 3 and coating 6. The foil strips 7, each of which has a thickness of 80-100 µm and is in the form of self-adhesive tape, are wrapped round the edges of the panel to adhere to the side edges and also throughout their longitudinal margins 8 and 9, to the surfaces 10 and 11. The width of the margin 8 in each case is 6 mm or less, whereas the width of the margin 9 is at least 125 mm. The purpose of the large-width margin 9 is to ensure that there is efficient conduction of heat from the central region of the panel to its outer edges, making the panel safe from thermal stress. This has the advantage that it is possible to use annealed glass for the sheet 1 in circumstances, for example in an outside architectural context, where only toughened (alternatively known as 'heat-strengthened') glass would otherwise have to be used.

Bonding of the strips 7 of metal foil to the epoxy coating 6 may be enhanced, or achieved without the use of self-adhesive tape, by bringing the foil into contact

with the melted epoxy powder before it cures, using the techniques described in GB-A-2 207 089 or GB-A-2 252 079.

Where the panel of Figures 1 and 2 is for use inside a building and not likely to be subject to moisture, it is possible to utilise a polyester powder for the coating 6 rather than an epoxy powder.

The manufacturing method described above may be carried out with or without the printing step. Where printing is not required, deposition of the epoxy powder for the coating 6 may be carried out before the polyester powder for the coating 2 has been fused. Deposition of a layer of the epoxy powder is in this case made onto a deposited layer of the polyester powder, powder upon powder, before heat is applied through the glass sheet 1 to melt both powders and cure them (for example using the oven of Figure 3). Because the heat is conducted upwardly from the sheet 1, curing of the polyester powder will (or with appropriate choice of powder mix can be arranged to) occur before that of the epoxy powder.

The panel described above may be used in the context of providing a spandrel for glazing of a building. The described panel may in this context provide the inner wall of a double-glazed spandrel unit illustrated in Figure 4.

Referring to Figure 4, the panel 31 described above, is located behind a rectangular, facing sheet 32 of partially-transparent or tinted glass (having a thickness, for example, of 6 mm). The panel 31 and the sheet 32 are separated from one another in the spandrel unit by a spacer 33 (having a thickness, for example of 12 mm).

The epoxy coating 6 of the panel 31 in the present case may be opaque and may be of white or dark colour, and the foil strips 7 instead of covering the side-edges of just the panel 31 may, as illustrated in Figure 4, be replaced by foil strips 34 covering the whole of the side-edges of the spandrel unit as well as wrapping round onto the epoxy coating 6 at the back of the panel 31.

1/3

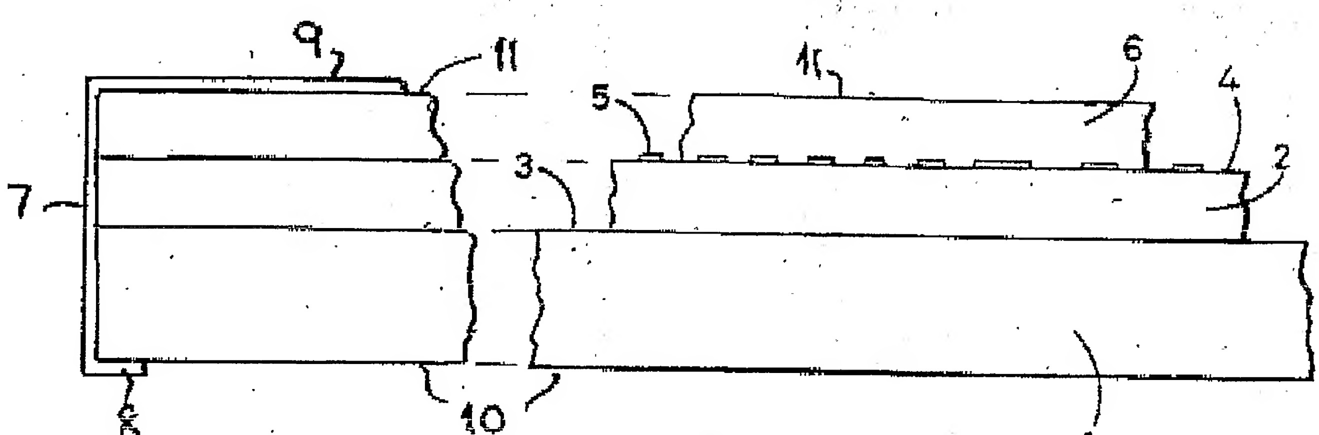

Fig. 1

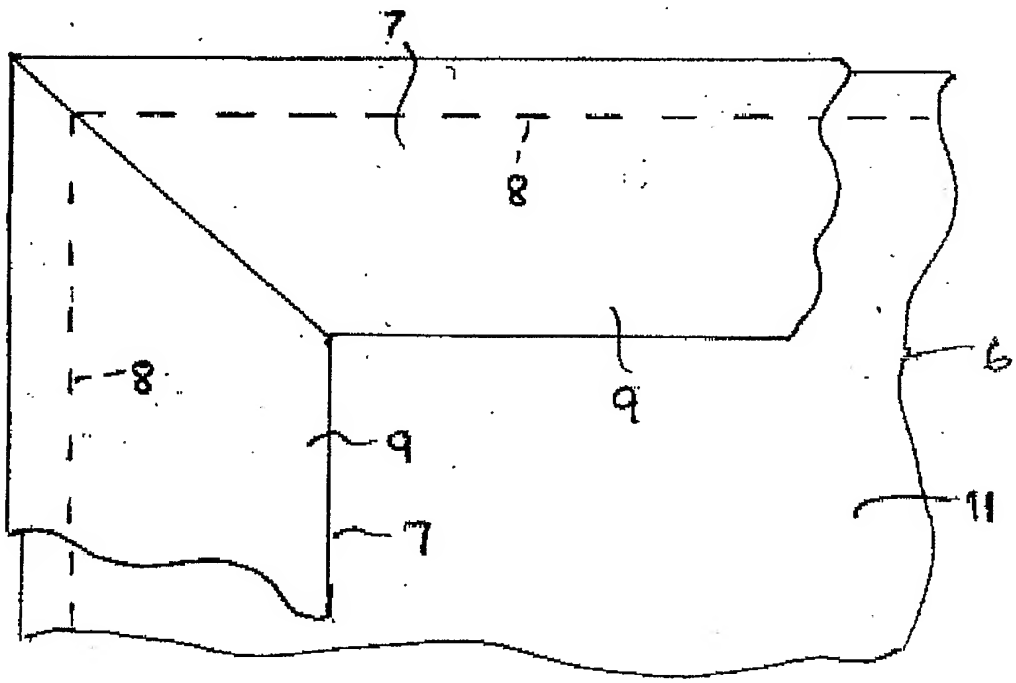

Fig. 2

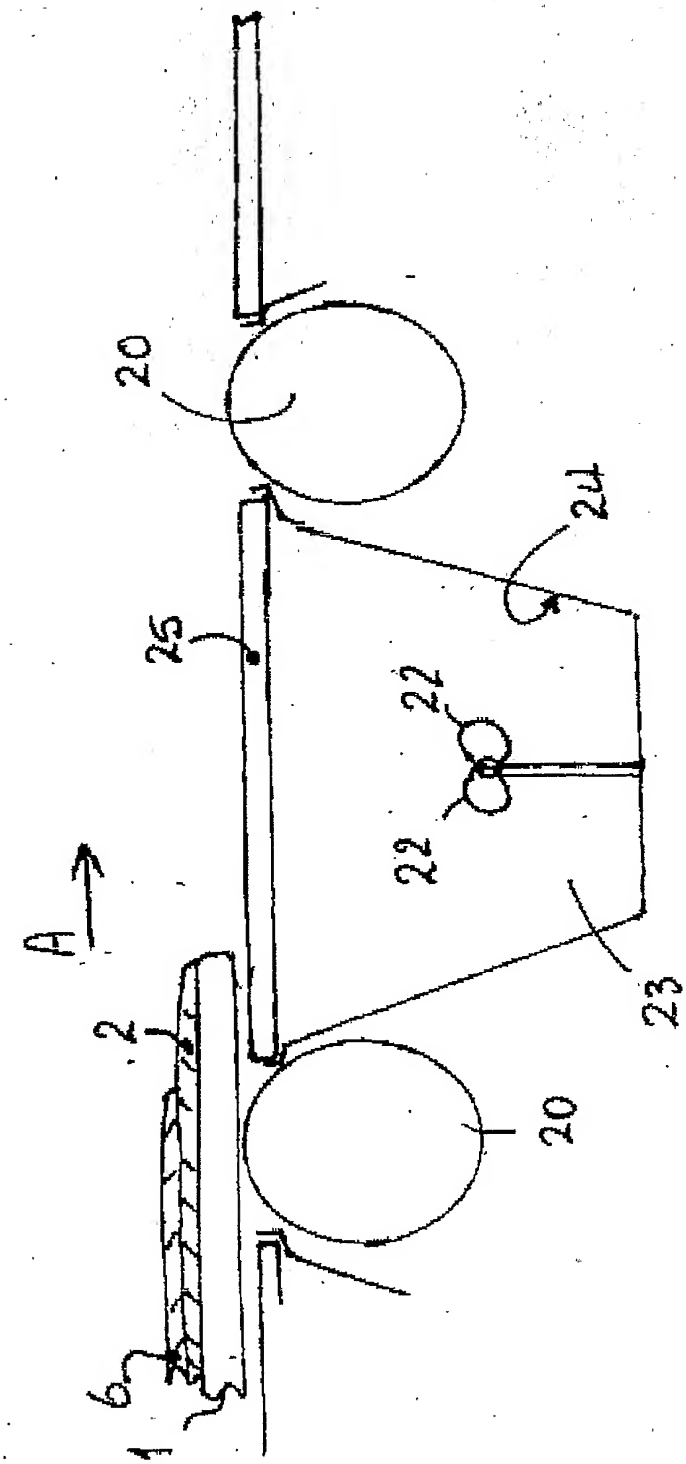

Fig. 3

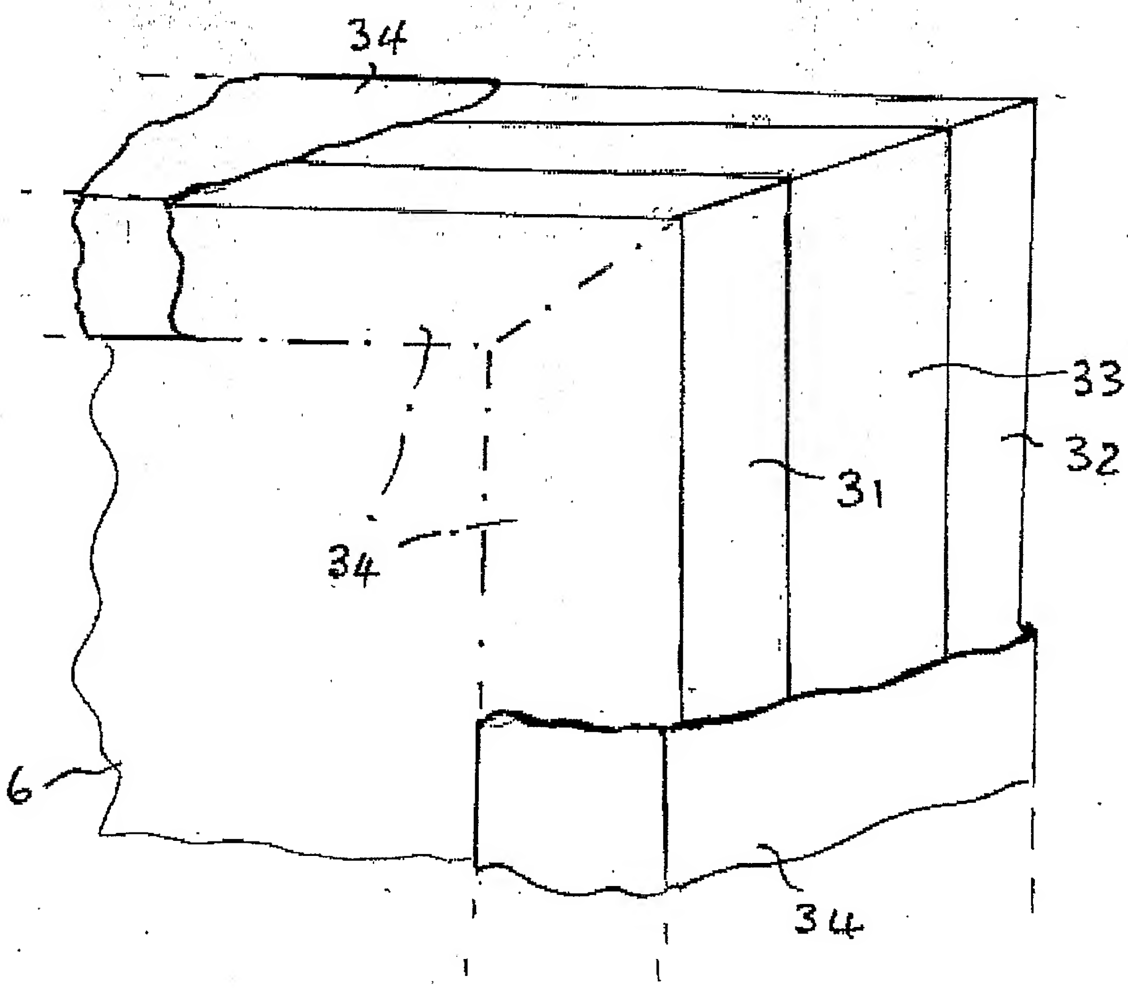

Fig. 4